Chapter I

Introduction

The sign language [1] is the only means of communication for deaf and hard-hearing people, to communicate among themselves and also with normal hearing community. Communication using sign language can be performed by a set of gestures. The gestures include hand, face and actions of other part of body to express ideas. It has a limited but complete set of vocabulary and grammar similar to spoken languages in one or more ways, but entirely different than spoken/written languages.

Spoken languages can be produced by some means so that the sounds uttered by the speaker can be heard and understood by listeners. However, sign languages can only performed by some kind of visual actions and expressions and understood by seeing those actions and expressions. The sign language requires some kind of processing in the brain to extract the actual meaning by the interpreter.

The spoken/written language of a country is different than the spoken/written language of another country. Almost all spoken/written language is completely recognized by one and all. The development of sign language is not very old as compared with spoken languages. In other words, except some countries, the sign language is in the developing stage. The development and use of sign language are now enforced or governed by the policymakers. Therefore, there is a huge difference between sign languages of different countries. It is believed that most sign languages are derived from British Sign Language [2] or American Sign Language [3] due to their developments started before a century ago.
The sign language also requires some attention with regard to automatic recognition and interpretation. It is only understandable by native signers of that sign language or interpreter who are trained in the sign language. In many practical situations, the deaf and hard hearing community wants to communicate with normal speaking people. Examples are railways, banks, educational institutions and so on. It is also not always possible for government to appoint sign language interpreters at such public places. In order to fit the gap, automatic sign language recognition systems are required. The role of such systems is similar with physical interpreters. These systems are equivalent to gesture based recognition systems. The main focus on sign language recognition systems are on gesture modelling, gesture analysis, gesture recognition and gesture-based application systems [4].

1.1 Scope of Communication Media

Communication media helps in exchange of information and thoughts between two or more persons (or groups). This is known as verbal communication. Persons with speaking ability can exchange information or thought by one person speaks and others listen. Similarly, one of the oldest communication media is writing. One can express his or her thought or information by writing on paper, palm leaf, rocks, etc. The persons can interpret the ideas of the writer in the form of reading the information written on paper or other material. Other modern communication media available are television, newspaper, Internet, telephone, mobile and so on. The communication of information or thought through these media requires no explanation.

However, the flow of information or thought can't be possible between people (or groups) having hearing, writing and speaking disabilities and with people with normal speaking, writing and hearing abilities. As a substantial population of the world community having these disabilities, they can use only sign language as a channel of communication. This kind of communication is known as nonverbal communication [5]. To help them some kind of aid is required.
1.2 Motivations for the Proposed Research

Commonly the sign language is recognizable by the signers and the individuals who know the language. Nevertheless, an individual who does not know the sign language can't recognize the meaning of gestural signs. It is very hard to interchange information among signer and non-signer community. There are several platforms in which a deaf or hard hearing individual want to exchange ideas with a non-signer person. The public platforms in which such communication is essential are public transport systems, banks, educational establishments, etc. [6]. To bridge these gaps in communication at various public places, a translator is required to interpret the gestures into text or speech. It is not possible to facilitate such physical interpreters’ at public platforms all the times, a computerized sign language recognition system can be useful to either communities for communication purposes.

1.3 Variations in Sign Languages

The variations in sign languages not only limited to the country to which it belong to, but also a handful amount or reasons behind this. The information on the variations of sign languages is helpful in the development of a sign language recognition system.

The regional type of differences in a sign language is due to cultural and other kind of differences between various parts of a country. The primary reason behind this is due to diverse variety of local spoken languages and their impact on sign language.

The second kind of variations in a sign language is due to social groups of signers. The signers are part of their family and friends; also they are inclined to religions or sporting groups. Therefore, the sign language of these signers is influenced by social groups.

The deaf community is not restricted to a particular country; they have also some effect on ethnic social class. The differences are identified by civilization, cultural and nationalism factors. In American Sign Language, black signers and
white signers use different signs for same words or phrases. The ethnic variations also affect the use of sign language differently as white and black signers were not shared same school for their education in the USA [7].

Sign language variation also includes the way male and female signers signs a particular word or phrase. The expression for the same sign performed by a male signer is not same with a female signer.

Technological changes have a great impact on the variation within a sign language. The addition of newer gadgets in the society discriminates old age signer from younger signers, in the way they signs for the same phrase or word.

Catholic deaf teenagers [8] were trained in various schools using one handed alphabets and their signs were based on “Irish Sign Language”. These differences are still available and elder signs are using the Rochester Technique [9], to sign in public places. The teenage signers are now trained using newer sign languages and are different than elder signers. One can claim that education has impact on the variations in a sign language.

The way deaf people sign is dependent on their family background. The children of a deaf parent use sign language differently than by children of a non-deaf parent. The manner of sign language communication of those who learned the language in early stage of life is also different than those who learned in the later stage of life [10]. Despite all variations mentioned above, fluent signers have much less difficulty in exchange of ideas with each other.

1.4 Need of Sign Language Recognition

Sign Language Recognition (SLR) [11] is the development of algorithms and techniques to appropriately identify a series of signs generated and to recognise their meaning. Several approaches in SLR mistakenly treat the problem only as gesture recognition. Hence, research has far focused on characterizing optimal features and classification techniques to correctly tag a given sign from a set of probable signs. Nevertheless, sign language is distinct than just a pool of well specified gestures.
Sign languages are mostly multi-faced channel; expressing ideas over many ways at the same time. The studies of sign language linguistics are in their initial stages, it is obvious that this makes various techniques used by speech recognition not suitable for SLR. Publicly available data sets are inadequate both in quantity and quality, rendering many conventional computer vision learning algorithms insufficient for the mission of building classifiers.

However, even in the presence of translation tools, most public amenities are not translated into sign yet. This is a big obstacle for sign language users’ community to access public facilities. Therefore, the automatic recognition of sign language is needed.

1.5 Challenges in Recognition of ISL

Sign languages are the only way of communication for deaf community, the way spoken community uses speech as the medium of communication. The ample research in the field of speech recognition resulted installation of speech recognition systems in many applications. For example, keyboard and mouse are still the primary input methods to operate a computer; however, in future situation will be changed due to speech recognition systems.

Active researches are also going on in the field of sign language recognition [12]. Sign language recognition research is still far behind, when compared to speech recognition research. The primary causes depend upon the late evolution of sign language and the development of such recognition systems is harder than the development of speech recognition systems. A speech can be uttered by a chain of sounds produced for a word or phrase, whereas this is not the case of sign language. Many things occurred at the same time in case of sign language. The movement of hands, facial expressions and other parts of body contributes to a word or phrase produced in a sign language. The difficulty in acquiring all these elements in a sign language makes it more complicate than that of speech recognition systems.

The meaning of a word or phrase in sign language can be changed due to its sensitiveness, as only expressions are involved. A set of other factors are also
involved [13] in sign language which differentiates it from spoken languages. The
focus is more on basic building blocks, from which all these appearances can be
considered. The basic building blocks in languages are the phonemes. However,
the problem exists how particular sign can be break down into its constituent
phonemes. The reasons are; firstly, the linguistic research on extraction of
phonology of sign languages is in its early stage and secondly, no standard
computational requirements have been established for a recognition system.

1.6 Origin of the Problem

People with hearing impaired and hearing deficiencies are able to
communicate by means of sign language. Unlike spoken languages, sign
languages uses manual, facial and body movements to express feelings. Like
spoken languages, sign languages are also country or region specific. Currently in
most countries, sign languages have been organized and standardized. Different
sign languages have phonological, grammatical and lexical variations. Family of
sign languages are available worldwide, namely, “American Sign Language”,
“British Sign Language”, “French Sign Language” [14] and “Irish Sign
Language”.

Sign languages are now recognized by government agencies and laws in
various countries. Enforcements in laws are provided as sing language is a
fundamental right of deaf and hard hearing people. However, many sign
languages till date are not recognized as legal languages in various countries.
Therefore, in many countries deaf community struggled for legalisation of sign
languages.

Sign language is treated as an alternate language for deaf community and is
different than spoken language. Sign language is executed in the left hemisphere
of the brain in the Broca’s and Wernicke’s areas [15] and should be treated as
natural languages.

The social, cognitive, linguistic and emotional growth of a deaf person
whether adult or child are fully dependent upon sign language. The same
timeframe is required to grasp sign languages as required in case of spoken
languages. The education on sign language should be given at early stages of life as it is helpful a faster learning process.

Language and culture are closely related. Deaf culture is entirely dependent and based upon sign languages. Deaf community can only communicate with other deaf individuals by the help of sign language. The communication between deaf and hard hearing community and speaking community is important in many circumstances. In order to bring them into the mainstream and to avail the common facilities available, automatic recognition of sign language is required.

1.7 Objectives

The intention of this research is "to develop a gesture recognition system that is capable of interpreting the gestures performed by the signer into text". As in India, no automatic gesture recognition system for ISL is available to meet this need; the focus of the proposed research is to create such a recognition system. The specific objectives for the development of an automatic recognition system for ISL are:

(a) Creation of static and dynamic data sets for ISL gestures.
(b) Enhancement of various pre-processing steps that are required to convert the gestures as input to the recognition system.
(c) To propose various feature extraction techniques that produces desirable features for the research.
(d) To analyse various classification techniques suitable for automatic recognition of ISL signs.
(e) To create test vector and evaluate the performance of the recognition system.

1.8 Research Contributions

The research contributions include the creation of a standard data set that is capable of developing of a system for automatic recognition of ISL gestures. In the procedure, some pre-processing steps are devised. Structural feature
extraction and histogram based feature extraction techniques are developed to cater the requirements, which are suitable for our gesture recognition system. Furthermore, various classification techniques are applied, which provides best recognition results from the system. The proposed system can also handle video gestures to extract meaning of video gestures up to word level.

1.9 Potential Applications

The potential applications of the proposed sign language recognition system are as follows:

(i) **Interpretation** - The gesture recognition system can replace a physical interpreter, who can automatically understand and performs gestures in sign language.

(ii) **Gesture driven interfaces** - The sign language recognition system can be useful as an input medium for human computer interfaces (HCI). The hand gestures can be useful in controlling computer or hand held systems.

(iii) **Video surveillance** - The proposed system can be able to detect many indecent activities present in a video repository generally used in surveillance of gated residential colonies or at traffics.

(iv) **Remote interpreting and data communications** – An automatic gesture recognition system can be helpful to sign language users to communicate with each other over videoconferencing. To save a large amount of communication bandwidth by transmitting the video data, the recognition system can accepts information in the form of video, converts the video data into text, transmits the text to the receiver’s terminal and translates the text into sign gestures for the user at the receiver's end.

(v) **Assistance for hearing community** - The hearing community can be able to understand the signs performed by the hearing-impaired people by help of the recognition system.

(vi) **Medical Record Transcription** - In place of writing on a paper, the
patient details can automatically be recorded in a textual form. The concern doctor can record patient history by performing gestures. The gesture recognition system accepts the gestures, converts them to desired text and stores the text in a database automatically.

1.10 Organization of Thesis

The remaining chapters of the thesis are organized in the following manner.

The focus of chapter II is on the existing works in automating the process of sign language translation. A detailed description about sign languages of the world, similarity and variations are discussed. The development or collection of data sets, images pre-processing steps applied, best suitable feature extraction techniques adopted and implementation of various classification techniques by researchers at international and national level are discussed in this chapter. The challenges faced, and ideas proposed by various researchers are analysed in detail. This helps in finding problems associated such as data set design and some new research directions in this area.

The detailed methodology and design techniques used in carrying out the research are discussed in chapter III. A detailed study on the data-acquisition methods used in conducting research is addressed. The pre-processing steps required for image and video data processing are presented in detail. The general structure of the pattern recognition process is provided. The detailed feature extraction methods that are used in the research are explained. Finally, the existing classification techniques are analysed, as they are used in this work.

The detailed description of the proposed system is discussed in chapter IV. It includes, proposed framework, sign pre-processing, feature extraction, classification and sign interpretation. After comparing various steps in pattern recognition, the suitable techniques that are adopted by the proposed system are explained in this chapter. The evaluation of the proposed system in terms of accuracy, stability and consistency are explained.

An experimental setup is established through which test results at digit level,
alphabet level and limited number of word level are provided in chapter V. The results are verified against different combinations of feature extraction methods and classification techniques.

Chapter VI details the conclusions derived from the work. Verification of the objectives of this research and potential application of this research are discussed. The thesis closes with an outlook of some future research in this area.

1.11 Summary

This chapter provides a deep introduction to the definition, meaning, working and purposes of sign languages. The introduction on sign language provides some basic building blocks on the foundation for the automatic recognition process. This also helps in describing and analysing the basic concepts about ISL. The need and challenges in sign languages are explained. This indicates research in the automatic recognition of ISL is needed. The manual and non-manual signs and their importance are described. This helps in identifying the data set used in conducting experiments.

References

[7] Lucas, C., R. Bayley and C. Valli. *An Introduction to Variation in


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